TRANSACTIONS

OF THE

ILLUMINATING ENGINEERING SOCIETY

FOUNDED IN LONDON 1909 : INCORPORATED 1930.

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32 VICTORIA STREET
LONDON, SW1

NOTES ON RECENT MEETINGS AND EVENTS

Opening Meeting in London.

The opening meeting in London took place at the E.L.M.A. Lighting Service Bureau (2, Savoy-hill, London, W.C.) on October 13. In accordance with the practice initiated in 1935 an opportunity was provided for members and friends to have a preliminary view of the exhibits illustrating progress in illumination and photometry at 4.30 p.m.

At the subsequent meeting, which commenced at 5.30 p.m., the minutes of the last meeting were taken as read and the names of applicants for membership (see p. 158) were announced. The new President, Mr. A. Cunnington, was then introduced by the retiring President, Mr. A. W. Beuttell. The President conveyed the cordial thanks of the Council and members to Mr. Beuttell for his services as President during the last session and to Mr. Percy Good for his services as Honorary Treasurer during the past three years.

The usual awards at the opening meeting were then made. Mr. Ralph G. Hopkinson received the Gaster Memorial Premium for his paper entitled "The Photographic Representation of Street Lighting Installations," read at the joint meeting of the Illuminating Engineering Society and the Royal Photographic Society on December 17, 1935. Mr. W. R. Stevens was awarded the Silver Jubilee Commemoration (1934) Award for his experimental work on the Thermal Endurance of Illuminating Glassware.

The President then delivered his address, which will be found *in extenso* on pp. 159 to 162.

The usual report of progress, prepared by the Technical Committee, was then formally presented by the Hon. Secretary.

After an interval for refreshments the various exhibits were briefly presented and described. These were again numerous and varied in character. Thirty-five exhibits (some comprising several distinct items) were included in the final list. Special interest was aroused in the new types of electric discharge lamps, some specimens of which were exhibited and described by Mr. W. J. Jones in his opening remarks. Many new types of fittings and photometric appliances were also exhibited and there were several models of interest, including one illustrating British requirements in the lighting of aerodromes for night flying.

A fuller list of these exhibits will appear in the next issue of the Transactions, in which the report of progress will appear.

Meetings in Manchester and Birmingham.

A number of the exhibits arranged in London were also on view at the meetings held in Manchester on October 20, and in Glasgow on November 3. At the former meeting, Mr. R. O. Ackerley was invited to give an introductory address reviewing progress, and a similar address was delivered by the President at the meeting in Glasgow.

Regular series of meetings in both these cities have been arranged for the first time in Glasgow, where Mr. T. Catten is acting as honorary secretary.

The attention of members is drawn to the arrangements for local meetings at these centres, and it is hoped that they will bring them to the notice of any friends in these areas.

Informal Meeting on October 27.

The first informal meeting of the session was held at St. Ermine's Hotel (St. James's Park, Westminster), on Tuesday, October 27, when Mr. F. C. Smith presided. A resolution to the effect that "Statutory regulations laying down standards of illumination for lighting factories, streets and public buildings are essential in the interest of progress," was proposed by Mr. R. O. Ackerley and supported by Mr. M. G. Bennett. It was opposed by Mr. A. P. Iliffe and Mr. G. Herbert. There was an interesting discussion in which the following, among others, took part: Mr. P. S. Barton, Mr. J. Bateman, Mr. A. W. Beuttell, Mr. A. C. V. Bristol, Mr. W. E. Bush, Mr. A. Cunnington, Mr. E. W. C. Day, Mr. J. S. Dow, Mr. Percy Good, Mr. Howard Long, Major J. Maitland Jones, Mr. C. A. Morton, Mr. E. W. Murray, and Mr. W. R. Stevens.

The Section on Photometry.

Several meetings have been arranged by the section dealing with photometry and allied matters, the first of the special sections to be created by the Society. Members and friends are welcome to all such meetings, but as they are of a somewhat specialised character notices are only circulated to those who express a desire to receive them.

Any members who wish to join the section on photometry and to receive notices of meetings should send in their names to the honorary secretary (Mr. K. F. Sawyer, Watson House, Townmead-road, Fulham, S.W.6), if they have not yet done so.

PROVISIONAL PROGRAMME OF MEETINGS

General Meetings in London

1936.

Oct. 13th. **Opening Meeting:—**

4.30 p.m. The **Exhibits** illustrating Progress in Illumination will be open for inspection.

5.30 p.m. The **Presidential Address** will be delivered by MR. A. CUNNINGTON and the usual Report of Progress will be presented.

6.15 p.m. Light refreshments.

6.45 p.m. Demonstration of Exhibits.
(Held at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2.)

Oct. 27th. **Informal Meeting:** devoted to a discussion on **"Statutory Regulations on Lighting; A Help or A Hindrance."** (Held at the St. Ermin's Hotel, Caxton Street, Westminster, S.W.1.)

Nov. 10th. A Paper read by MR. E. W. MURRAY dealing with **"Factory Lighting and Accident Prevention."** (Held at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1.)

Nov. 17th. **Visit to Gatwick Airport.**

Dec. 8th. A Paper will be read by MR. P. FREEDMAN dealing with **"Low Voltage Neon."** (To be held at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1.)

1937.

Jan. 12th. A Paper will be read by MR. J. W. HOWELL dealing with **"Some Important Considerations in Colliery Lighting."** (To be held at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1.)

Feb. 9th.
Mar. 9th.
April 13th. For these dates Papers on Research on **Brightness in Connection with Television, Diffusion and Shadows, Special Problems in Industrial Lighting, Street Lighting, The Lumen Rating of Electric Incandescent Lamps** and other topics have been suggested.

Mar. 16th. The **Annual Dinner** will take place at the Trocadero Restaurant, Piccadilly Circus, London, W.1. (7 for 7.30 p.m.)

May **Annual General Meeting.**

(It is hoped to arrange several other visits to places of interest during the Session.)

Unless otherwise announced Meetings will be held at **7 p.m.** *and will be preceded by light refreshment at* **6.30 p.m.**

Meetings of Photometric Section

1936.

Nov. 24th. An Address by MR. J. GUILD on **"Colorimetry and its Relation to Photometry"** (at the Borough Polytechnic, London, S.E.). **(6 p.m.)**

1937.

Feb. 22nd. An Address, with demonstrations by MR. G. T. WINCH on **"Some Practical Aspects of Precision Photometry"** (at the Research Laboratories of the General Electric Co., Ltd., Wembley).

Hon. Secretary: MR. KENNETH F. SAWYER, *Gas Light an Coke Co., Watson House, Townmead Road, London, S.W.6.*

Local Meetings

MANCHESTER

1936.

Oct. 20th. **Opening Meeting: Address** by MR. R. O. ACKERLEY, followed by **Exhibits.**

Nov. 24th. **"Architectural Lighting,"** by R. O. SUTHERLAND, A.R.I.B.A. The Engineers' Club, Albert Square, Manchester. **(7.15 p.m.)**

1937.

Jan. 5th. **"Home Lighting,"** by MRS. M. PENDER CHALMERS, Reynold's Hall, College of Technology, Sackville Street, Manchester. **(7.15 p.m.)**

Feb. 17th. Institute of Civil Engineers (Manchester District), **"Road Lighting and Road Surfaces,"** by G. H. WILSON, B.Sc., Literary and Philosophical Society (Room 36), George Street, Manchester. **6.45 p.m.** Tea **6 p.m.)**

Mar. 23rd. **"Works Lighting,"** by a Works Engineer or Manager, The Engineers' Club, Albert Square, Manchester, **(7.15 p.m.)**

GLASGOW

1936.

Oct. 22nd. A Paper on **Electric Discharge Lamps and their Applications,** by Mr. L. J. DAVIES.

Nov. 3rd. **Address** by THE PRESIDENT (MR. A. CUNNINGTON) followed by **Exhibits,** at the Royal Technical College, Glasgow. **7.30 p.m.**

Dec. 17th. **Factory Lighting and Accident Prevention,** by Mr. E. W. MURRAY, at the Cadora Restaurant, Glasgow.

On subsequent dates (Jan. 14th, Feb. 18th, and Mar. 18th) other events to be announced.

Hon. Secretary: Mr. T. CATTEN, *Lighting Service Bureau of Scotland, 29, St. Vincent Place, Glasgow.*

DUBLIN Programme in course of preparation.

Hon. Secretary: Mr. J. CREAGH, 1, *Ashbrook Villas, Ashbrook House, Sallymount Avenue, Ranelagh Dublin.*

APPLICATIONS FOR MEMBERSHIP

Elections Pending.

At the opening meeting of the Society, held on October 13, 1936, the names of the following applicants for membership were presented:—

CORPORATE MEMBERS:—

Boulderstone, J. B....3, Fenstanton Avenue, North Finchley, LONDON, N.12.

Caine, K. E. .....311, Great West Road, Hounslow, MIDDLESEX.

Derring, C. .....8, Cavendish Road, LEEDS, 1.

Dodimead, H. M. ...British Commercial Gas Association, Gas Industries House, 1, Grosvenor Place, LONDON, S.W.1.

Geiss, Dr. W. .....Lysterlaan 40, Eindhoven, HOLLAND.

Glover-Clark, E. ..... Crosby House, Londonderry, Northallerton, YORKS.

Hall, R. H. .....22, Tees Avenue, Perivale, MIDDLESEX.

Harris, J. B. .....146, Ellesmere Road, LONDON, N.W.10.

Harvey, C. .....22, Fitzroy Square, LONDON, W.1.

Juliusburger, F. .....59, Ebury Street, LONDON, S.W.1.

Keefe, H. J. .....Newbold and Co., 72-74, Grays Inn Road, LONDON, W.C.1.

Lay, S. D. .....Kings House, King Street, WEST MANCHESTER.

Odom, M. F. .....The British Electrical and Manufacturing Co., 13, Charlotte Street, Oxford Street, LONDON, W.1.

COUNTRY AND FOREIGN MEMBERS:—

Baker, J. C. .....309, Main Street, Huntington Beach, California, U.S.A.

Bayliff, T. .....71, Amulree Street, Shettleston, GLASGOW.

Berinstein, J. C. .....1339, Lunt Avenue, Chicago, Ill., U.S.A.

Brandt, F. .....781, 142nd Street, New York, U.S.A.

Bridge, F. W. .....Woodlyn, 4 Broad Oak Road, Accrington, LANCASHIRE.

Burdes, L. .....Corporation Electricity Department, Colston Avenue, BRISTOL.

Comrie, G. E. L. .....4, Silverknowes Terrace, EDINBURGH, 4.

Crittenden, E. C. ....National Bureau of Standards, Washington, D.C., U.S.A.

Fitzpatrick, J. C. .....14, Kenilworth Road, Rathgar, DUBLIN.

Gallagher, T. H. .....45, Mid Abbey Street, DUBLIN.

Gallagher, S. .....45, Mid Abbey Street, DUBLIN.

Harvey, Wade .....149, Church Road, Penn Fields, WOLVERHAMPTON.

Houlihan, G. .....55, Botanic Avenue, Glasnevin, DUBLIN.

Johnson, H. W. .....Apartado 2766, Mexico, D.F. MEXICO.

Lindsay, A. .....173, Bath Street, GLASGOW.

Lix-Klett, E. .....229, Florida, Buenos Aires, ARGENTINE REPUBLIC, S.A.

Lyons, C. J. .....31, Mount Prospect Avenue, Clontarf, IRELAND.

MacNaughton, V. P. ..8, Pearse Street, DUBLIN.

McNicol, J. M. .....116, Clyde Ferry Street, GLASGOW.

Neale, E. G. .....6818 Avalon Boulevard, Los Angeles, Californa, U.S.A.

Palmer, R. A. .....Duke Power Company, Charlotte, N.C., U.S.A.

Ryan, F. J. .....3, Lower Abbey Street, DUBLIN.

Ripley, D. L. .....427, Olympic Avenue, Buffalo, New York, U.S.A.

Scott, J. H. .....51, Waterloo Street, GLASGOW.

Silver, G. Gordon ...188, West Regent Street, GLASGOW.

Thorncroft, E. W. ...Essantee Switchgear, Ltd., Kembla Buildings, Margaret Street, Sydney, AUSTRALIA.

Weerdt, H. E. de ....103. Bath Street, GLASGOW.

Elections Completed.

At this meeting the names of those announced on May 12, which were published in the issue of the Transactions (Vol. 1, No. 6, p. 82, June, 1936), were read again, and these applicants were formally declared members of the Society.

Privileged Membership.

The Council has approved the continuation during the present session of privileged membership on behalf of Dr. J. W. Whitaker (Croydon Polytechnic) and Mr. J. W. Bispham (London County Council Education Department). It has also nominated a third privileged member for the current session, Dr. G. P. Crowden, of the London School of Hygiene and Tropical Medicine.

PRESIDENTIAL ADDRESS

By ARTHUR CUNNINGTON, B.Sc., M.I.E.E.

(Address delivered at the Opening Meeting on October 13th, 1936.)

My address must naturally begin with an expression of thanks to you for electing me your President during the forthcoming session. I do appreciate the honour, and am, at the same time, conscious of the responsibility involved. A glance at the line of past presidents that one is called upon to follow has a humbling effect and makes it seem a difficult task to be worthy of the past, but I can assure you that I will do whatever I can to advance the work of the Society.

You will probably expect me, as a railway lighting engineer, to say something about railway lighting, but I do not propose to make this the principal theme of my address, partly because that section of railway lighting with which I am principally concerned does not differ very much from lighting practice generally, but mainly because I wish to leave time to speak as a representative of consumers of lighting. The point of view of the consumer has not been very prominent at our meetings, but it should not be neglected, and may, if considered properly, lead to the expansion of the Society in new directions. Before dealing with this aspect, however, let me mention briefly a few points of interest that occur to me on the subject of railway lighting.

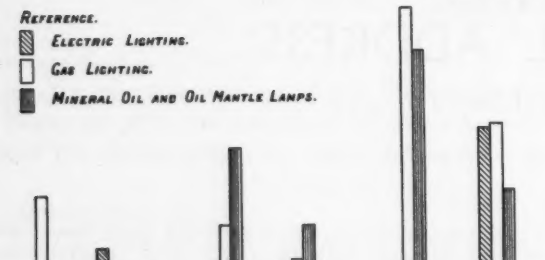
Railways have always been rather a butt for the general public, and the lighting of railway stations has not infrequently been the subject of adverse comment, but it is only fair to mention that, in general, conditions have improved substantially during recent years, and, where a definite attempt has been made to attain to modern standards, there have been some really good results.

There are, of course, very many opportunities for the use of light for special purposes on the railway, and none more important than the illumination of direction signs, train indicators, and so on. As some of you know, I have been interested in methods of illuminating boldly legible station name-plates—an obvious aid to the public—and it is now quite a number of years since experiments were first made at Waterloo with time-tables illuminated from behind. During recent years the adoption of illuminated direction signs and notices of destinations of trains has increased considerably, following the lead of the Underground Railway, to whom credit must be given for pioneering in this direction.

An appeal to the eye in this form seems a very natural way of giving directions, and will probably be more widely extended in the future, although a rival method has shown itself on the horizon. We now have the loud-speaker for directing passengers to the correct platform, for announcing the stations at which a particular train stops, and even for telling us to "stand clear of the gates." Let us hope for the sake of our already tired ears that light will remain the primary medium for travelling directions, and that oral devices will be used only for crowded occasions.

The lighting of signals is another "specialist" aspect which is coming much to the fore, and which might well form the subject of a separate paper before this Society. Colour light signalling is bringing about a revolutionary change by dispensing with an enormous amount of hand-worked mechanism. The system is likely to be extensively used owing to the simplicity with which the relative position of trains on a track can be indicated by lights of different colours automatically controlled by the trains themselves. We, as illuminating engineers, may take some pride in the fact that the progress in electric lamp bulbs and their present-day reliability, coupled with the wide availability of electricity from public supplies, has had much to do with the extension of colour light signalling to country areas.

Before coming to my main subject, I may perhaps draw your attention to a respect in which railways are unique consumers of lighting, viz., that they are users of all kinds of illuminants—electricity, gas, paraffin oil, petrol gas, acetylene, and vaporised paraffin—the last two being mainly used for temporary lighting when carrying out night work on the permanent way. There is a tendency for self-contained systems of lighting, i.e., those using oil or acetylene, to be discontinued owing to the rapid development of public gas and electric lighting services in what have hitherto been regarded as outlying districts. The Southern Railway is likely soon to be in the happy position of having a supply either of electricity or gas available for practically every station on its system. It may be of some historical interest to notice the change that has taken place during the last twenty-five years in the methods of illuminating stations. I am in a position to give you a comparison between 1911 and 1936 in respect of the stations on the former South-Western Railway (one of the constituents of the Southern Railway) and a diagram has been prepared to show the change. The increase in electrically lighted stations and the corresponding decrease in oil lighting is not quite so marked when the system is taken as a whole, because the total includes a number of remote stations in Devon and Cornwall that are still without gas or electricity, but in the area within a radius of about fifty miles from London (for which a separate diagram is given) there are not many oil-lighted stations left, and these are only waiting the opportunity for conversion. Another little item of history is worth passing mention, especially in view of the idea very prevalent at one time that railways were slow in adopting modern methods. It will interest members



of this Society to know that railways were among the earliest organisations to recognise the value of an expert lighting engineer to co-ordinate their lighting. The L.N.E.R. had a lighting engineer as far back as 1906, and the Southern Railway followed suit a few years later.

I should like now to deal with one or two aspects of lighting from the consumers' point of view, and they may conveniently be taken in logical order from the original source of energy to the final illumination produced:—

1. Need for Uniformity in Supply.

This applies particularly to the voltage and character of electric supplies, and when one mentions that on the Southern Railway alone there are still no fewer than eleven different voltages and types of supply, the desirability of completing rapidly the standardisation now being carried out need hardly be stressed. Uniformity is also desirable in regard to the calorific value of gas, and in view of the very general use of a calorific value in the neighbourhood of 450-500 calories per cubic foot it would not seem much to ask that the Gas Companies should ignore the small differences of local operation and work to a standard figure of calorific value. The amalgamation of smaller undertakings should help to bring about this desirable state.

2. The Need for Simplicity in Methods of Charging.

To one who has to deal with dozens of different Supply Companies the multiplicity of methods of charging is brought home in a very acute fashion, and the time is more than ripe for some statutory settlement of the broad basis of charging both for electricity and gas. The two-part rate has now become very general with Electricity Companies. It is being taken up by Gas Companies, and is, no doubt, an equitable method of adjusting the rate to the supply given. But some control is urgently necessary to ensure uniformity for the benefit of the consumers. There must be no further extension of the present chaos of systems. By all means let us be as scientific as we can in devising tariffs properly related to costs, but let the passion for scientific accuracy be tempered with a fair regard for the consumer's point of view. Does it really matter so much if a few consumers are charged at a rate which does not quite accurately represent their cost to the Supply Authority so long as the great bulk are assessed at a fair average figure? What the consumer wants, above all things, is simplicity and uniformity.

The illuminating engineer has done his best in regard to measurements, and in judging lighting fittings we generally know the light output in lumens per watt or per cubic foot, but when it comes to making comparisons of lighting costs as between one set of consumers and another, we are faced with a chaos of methods in charging which makes it almost impossible to arrive at any fair estimate of values. These matters may not be directly concerned with illumination but in as much as they hamper the consumer, they act as brakes and retard the advance of lighting.

3. The Need for more Attention to the Maintenance Aspect in the Design of Fittings.

This is one of the points connected with conversion of energy into light which has not always received sufficient attention. There has been a tendency to concentrate on the efficiency of a fitting in producing a maximum of light for a minimum expenditure of energy but I think that lighting fittings should be viewed more critically from the point of view of upkeep, accessibility for cleaning, and *ultimate* appearance. Some of the fittings sent out with an attractive finish are obviously designed in such a manner that a twelve months' attack of ordinary London atmospheric conditions will entirely spoil their beauty unless they are given attention for upkeep which is out of all proportion to the value of the lighting. Whilst bringing forward this adverse criticism I am fully aware that some manufacturers of lighting fittings have devoted much study and research to the aspect of maintenance, and I would like to pay tribute to the very practical designs that have resulted. Nevertheless there is room for much improvement in the general market.

4. The Need for Attention to Surroundings.

Having converted the energy into light there is still the question of the effect of surroundings and although we cannot always exercise control in this direction, it is important to make the best of the light available wherever the surroundings can be adapted.

Those who have been concerned with the flood lighting of exteriors are fully alive to the detrimental effect of grime on reflecting surfaces. Even here in London the loss of efficiency due to dirt is considerable and in some Midland towns the effective flood lighting of public buildings must be almost impossible. It would be a great service for the lighting industry if during the Coronation period the owners of large premises in London and elsewhere would

have them steam-cleaned. Such a step, if widely carried out, would decidedly lighten the task of flood lighting experts and the day time aspect of our buildings would be improved.

The effect of reflecting surfaces is not only important from the point of view of pure efficiency, but it obviously has considerable psychological significance. An instance that will be familiar to many is a concert hall in London where the general colour of the interior is deplorable in both respects. It is psychologically depressing and, owing to its deficiency in reflecting power, it tends to cause the lighting fittings to appear very glaring. The lighting engineer is faced with this dilemma—if he provides a normal candle power the building looks only half lighted, but if he increases the candle power to compensate for the dull walls, the brighter light sources appear unpleasantly glaring.

Then again the modern tendency to regard light as a medium of decoration is one that we cannot afford to ignore. The artist in the matter of interior decoration has been conspicuously absent from our ranks, but light in its many forms and colours is now such a valuable tool in the hands of an artist who has studied its possibilities that it is surely high time that this branch of lighting technique had some representation in this Society.

Much that I have said is no doubt common ground to illuminating engineers and you may feel that I have rather stressed the obvious, but it is necessary to remember that there are many authorities and committees who control lighting to whom these considerations are by no means so obvious; and besides these we must not overlook the ordinary rank and file—the daily consumers of lighting. It is undoubtedly one of the duties of our Society to broadcast the fundamentals of good lighting, and propaganda of this kind, in order to carry a maximum weight, should come from the Society as a whole rather than from its constituents, e.g., those interested firms whose primary concern is in selling a particular illuminant or lighting device. In saying this I do not wish to minimise the splendid work that has been done and is still being carried on by these interested parties. No member of this Society can fail to recognise the value of the driving force originating from individual firms and associated companies. The hall in which this meeting is being held is a very living testimonial to the activities of this kind, but, to use an oft-quoted phrase, " patriotism is not enough." We want something more than the patriotism of firms for their own associations. We need the broad outlook of the whole lighting world and it is for us to find out how the Society can strengthen its position in this respect. I think we may look for some advance by the training of more all-round lighting engineers to put into practice the ideals of our Society.

In the realm of public lighting much has already been done to get such trained men placed in positions of control by the good work of the Association of Public Lighting Engineers, but even now we have too frequently the pathetic spectacle of a lighting committee having to accept the figures of lighting costs for a particular system of lamps as submitted by a local gas or electric company because they have no trained and independent expert to whom they can turn for a proper report on the comparative values of various proposals that may have been put forward. No doubt it is true that the smaller local authorities cannot justify the expense of a trained lighting engineer working full time, but at least we ought to be in a position to offer the services of consulting lighting engineers who could be appointed *ad hoc* to report on a scheme.

5. The Need for Independent Lighting Experts.

Public lighting has been in the limelight recently. It is natural therefore that the need for fully qualified and independent public lighting enginers should be emphasised, but public lighting authorities are by no means the only bodies that might well employ lighting experts. The wide scope for the efforts of such experts on railway systems has already been mentioned, and there are similar opportunities in the departments of authorities concerned with docks and harbours. Surely several of the Government Departments might with advantage maintain one or more lighting experts, and the same applies to many large industrial organisations and multiple stores.

Where, too, are our consulting lighting engineers? men of independent outlook fully trained in modern methods of lighting and capable of assessing the true value of any system offered in relation to the local setting, not merely judging it on a paper efficiency. I have already indicated some of the features which make it difficult to arrive at a true comparison of different systems of lighting for a particular installation. One is apt to be impatient of comparisons merely of therms and units when experience shows that there are many other considerations frequently overlooked by the would-be assessor of values. There is ample evidence that such independent and fully qualified consultants are a necessity if progress is to go hand in hand with fairness to competitors.

Then again, can we not find more room for the consumer in the home. She and her male counterpart have not hitherto been represented specifically in our Society, although from the very first provision was made for the inclusion of ladies in its membership. We should not only welcome the entry of such ladies as choose to make illuminating engineering their vocation but be glad to have in our ranks any who have a general interest in lighting, and we notice with interest the movement towards forming a Women's Lighting Circle, the organisers of which may be assured of our sympathetic interest and aid.

Another direction in which we are hoping for early development is by bringing into our ranks more of those engineers connected with the maintenance of lighting in large stores, factories and institutions, who have come to be appointed (and we hope will be appointed much more frequently in future), largely because of the complexity of the engineering problems that arise under modern conditions. We feel that there must be many such whose inclusion in our Society would be of mutual benefit and we hope that the new session will see the formation of an Industrial Section.

May I conclude with a brief personal note? Having been called to preside over this Society in its 27th

year it is natural that I should glance back at the days of its beginning when I was acting as an assistant to its founder. No one who worked with Leon Gaster could doubt that his driving energy and astute way of pulling the right strings contributed much to the laying of firm foundations. I need only remind you of the getting together of men like Silvanus Thompson and A. P. Trotter, of Mr. Gaster's successful bringing of the Home Office into the movement through the instrumentality of Mr. D. R. Wilson, and of his capacity for linking us up with workers in the same field abroad through his personal knowledge of so many continental and American leaders in lighting. This driving force was of course always backed up by the quiet and steady work of Mr. Dow and I look back, I might almost say with affection, to the days when I was privileged to work, though in a humble capacity, with these pioneers.

I do not wish, however, to live in the past and I am aware that there are many younger members of the Society who are not particularly interested in the laying of the foundations. They are concerned mainly with the present, and perhaps a little with the future. The majority of the members are in the Society for what they can get out of it. That is quite natural and there is no need to pretend that there is any conflict between that idea and the main objects of the Society, but it is important to remember that in a broad sense we can only get out of the Society what we put into it and I would conclude with a plea for a greater readiness on the part of the newcomers to bring forward any contributions that they may have to the common pool. We have had splendid pioneers. We must have equally splendid torch-bearers to lighten our darkness.

STREET AND ROAD LIGHTING

By Dr. MERRY COHU of Paris *(Member)*

(Presented at the Annual General Meeting on Tuesday, May 12th, 1936)

Everyone (in the engineering world) is convinced that good street and road lighting does not depend solely upon the distribution of light and evenness of illumination. The discussion of relative merits between central, side, or staggered lighting, mounting height, etc., is also entirely sterile unless due attention is given to other items. Unfortunately, the question is very complex, and the preceding factors are quite insufficient to determine the contrasts which are essentials in promoting good visibility. Contrasts between an obstacle and its background are not a question merely of the nature and condition of the street surface. As Messrs. Davies, Maxted and Lucas have pointed out in their report upon "The importance of kinematical factors in roadway illumination," such contrasts may exist, for instance, between a pedestrian and walls, hoardings, and fences, etc., although the most general background is, in fact, the street surface. Messrs. Smith and Sawyer have shown that only very seldom is any given object *entirely* silhouetted against the surface of the road; but, in most instances, some *part* of the object is, nevertheless, generally visible against the street surface.

It is evident, therefore, that in most cases the background formed by the pavement is of material importance, and sometimes may be the only item in promoting visibility. I quite agree that other backgrounds must be examined. But our primary idea in making tests of reflexion characteristics of pavements is that the problem is a most important one in highway lighting beyond the city limits because:

(1) There is then no possible bright background except in road and sky;

(2) The distance between the sources is, for essential reasons, usually greater than in cities;

(3) Since the speed of traffic is greater than in cities we find here the problem at its worst. It follows that if we are able to find a satisfactory solution to the highway lighting problem, the same solution may very likely apply also for urban installations. As you are all aware, the problem, in spite of its apparent simplicity, is really an extraordinarily complex one. I tried years ago to count the factors influencing the question and found at least twenty-eight different variables.

I do not believe that we shall be able to treat the question as a whole and succeed in solving it by statistical or by cut and dried methods. If by these means we once succeed in making an entirely satisfactory installation, we can consider ourselves lucky and say that all our variables have had just the desirable value in this specific case; but we cannot expect such a method to succeed in all cases.

The importance of the following variables must be considered:

Variables pertaining to the installation proper:
Type of luminaire, height, spacing, brightness, light distribution.

Variables connected with street surfaces:
Angle of incidence of light. Nature of surfaces. Plane of observation. Angle of observation, surface, profile, width, state of humidity. Brightness factor.

Variables related to obstacles:
Reflexion factor. Angle of incidence of light. Nature of surface. Shape of surface, shadows, plane of observation, angle of observation, speed of obstacle.

Variables related to observer:
Position, speed of reflexes, personal characteristics of vision, glare, state of vision, depending upon previous brightness in field of vision.

Unfortunately, many of these variables are interconnected, and any modification of one of them will affect others, and the final result, which is, in fact, the perception of obstacles. It has, therefore, seemed wise to us to proceed from the simple to the complex and first to deal systematically with the question of street surfaces with regard to their reflection characteristics as the chief item in the control of visibility. If properly utilised this reflection may enable us to detect (perhaps imperfectly, but, nevertheless, to detect) under most circumstances the presence of obstacles.

I want to emphasise the fact that I am not at all convinced that the unique solution of the question lies in the street surface's reflection. I think that we shall get closer and closer to the true solution in building up contrasts, in avoiding glare, in obtaining permanence of contrasts; but things will evolve slowly. If I deal at present with the question of reflection of street surfaces it is because this question seems a very important one among others equally important, and because if we want to understand the problem we must first disarticulate its various aspects, and, above all, try to understand "what happens" before learning "what to do."

Reflection Characteristics of Roads.

The reflection of road surfaces can be studied directly on the spot, i.e., in the streets. We can thus obtain extremely interesting results which are, however, of value only for a given installation and a given distribution of light. Our aim has been more specifically restricted to the determination of the reflection characteristics of samples taken from road surfaces, which are in fact "constants" for a given surface.

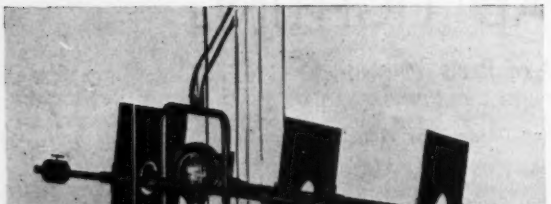


Fig. 1. Showing adjustable screens used to limit the beam.

Accordingly it was resolved to measure the brightness factor (ratio for a given illumination between brightness and illumination) which depends upon: Angle of incidence, plane of observation, angle of observation.

In order to enable us to study the reflection characteristics, the city of Paris has kindly put at our disposal samples of pavements, square in shape and of about 2 feet in length in side. These samples were actually taken from existing road surfaces.

They were lighted by a 5 kw. lamp fed at a constant voltage of 110 V., furnished by a d.c. dynamo driven by a synchronous motor. The lamp was suspended by a system of pulleys and counter weights which permitted its being placed at any intermediate height between the plane of the sample and the maximum height. A suitable set of adjustable screens attached to the lamp holder enabled us to limit a narrow beam in the direction of the sample (Fig. 1). Another set of screens placed on rails nearer to the sample gave to the incident beam a sharp edge (Fig. 2). The sample was itself placed on a strong stand movable on rails and resting on three small wheels, two being on one rail and the one on the other rail. Screws made possible the raising or lowering of the stand in order to set the sample in a perfectly horizontal plane (Fig. 3). Around the vertical axis of the stand was a horizontal arm supported on ball bearings which could revolve in all directions. This arm was bent vertically at right angles, and at its vertical end, there was attached, on an horizontal axis, another long arm carrying the sensitive receiver. This arm, and the receiver, were balanced with counter weights in order to be capable of occupying any position in a vertical plane. Owing to the two movements: rotation in an horizontal plane and rotation in a vertical plane, the receiver was able to occupy any position on the surface of a sphere of two meter radius.

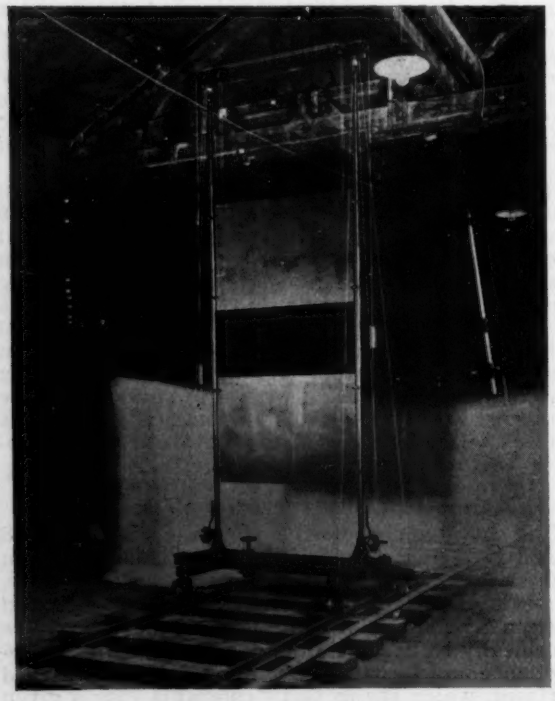


Fig 2. Further arrangement of screens.

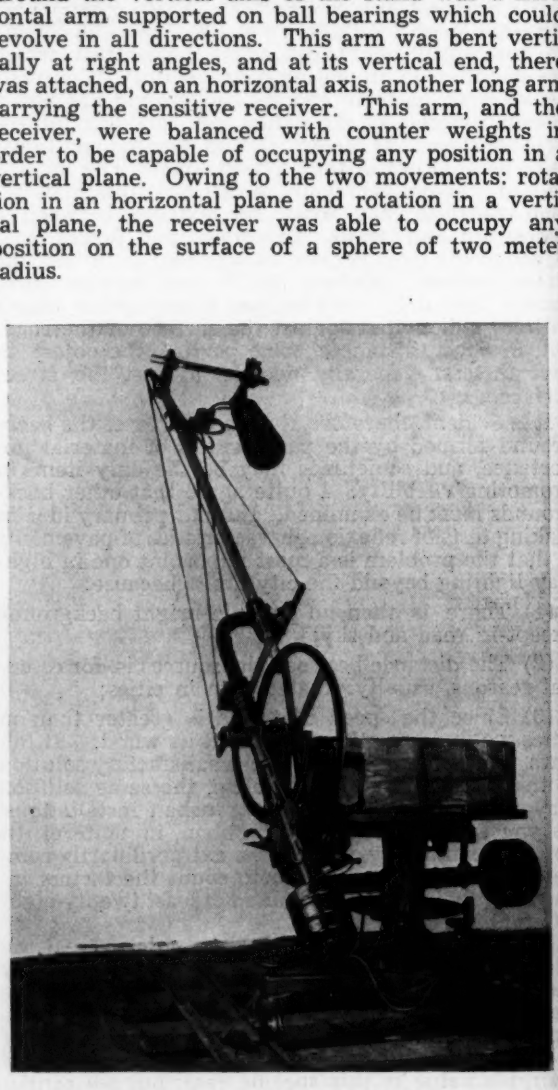


Fig. 3. Apparatus to regulate position of sample.

The receiver was a selenium photo element of about 7 cm. diameter, the active surface of which could be increased or diminished by an iris diaphragm. In order to prevent any stray light from reaching the receiver, the cell was placed at the top of a cone fitted inside with concentrical rings of different diameters. These rings prevented the possibility of light reaching the inside of the cone under very oblique angles, and being reflected by the surface so as to fall on the receiver. Dials gave indication of position for the horizontal arm and the arm carrying the cone. It was thus possible to obtain all incidences of light upon the sample by changing the height of source and distance of sample. It was also possible to study the brightness distribution of this sample in all directions within a hemisphere having its centre in coincidence with the middle of the sample.

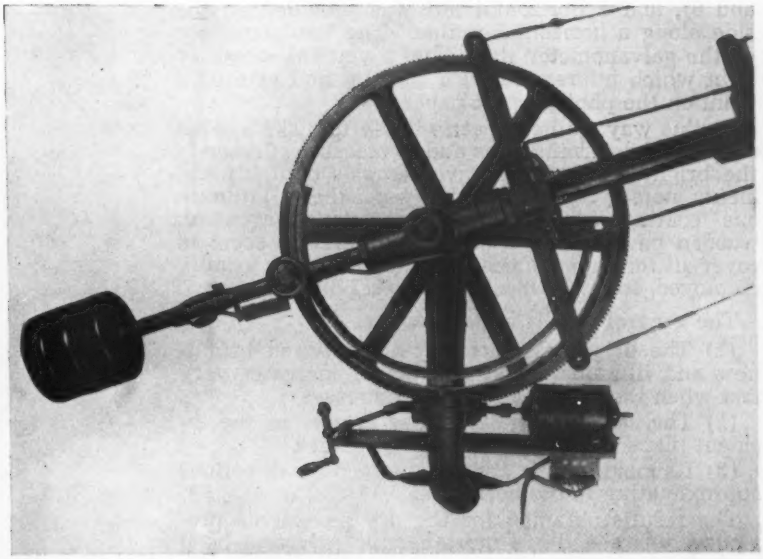


Fig 4. The arm carrying the receiver, fitted with a toothed wheel which engages with a screw attached to the rotor of the small motor.

The photo-electric cell was connected with a galvanometer of the Moll type, and of very high sensitivity. The results might have been plotted for various samples and different vertical planes in polar coordinates, but this would not have given a very clear representation of the whole phenomenon.

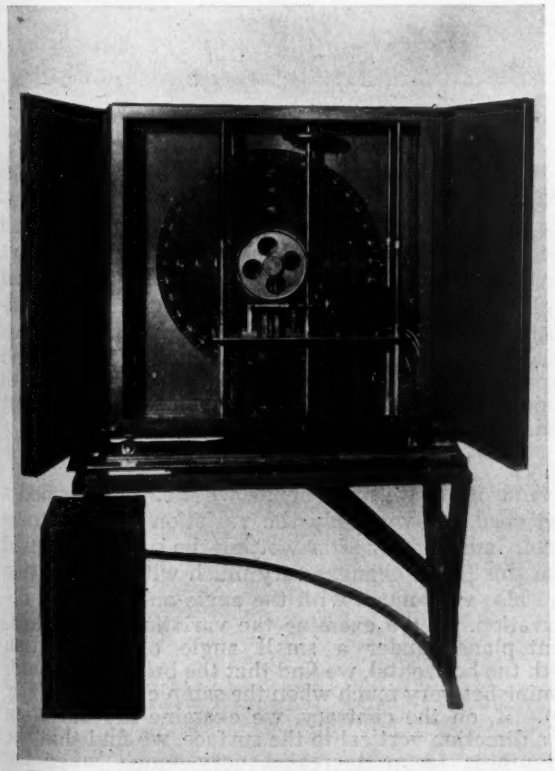


Fig. 5. The light-proof box containing the recording paper.

We decided to adopt the system utilising the projection on a sphere of the curves of same brightness factor which we call " isobrightness curves." However, only the assembly of the different curves close to each other could have shown clearly phenomenon as a whole for a given incidence of light. We attempted to build such a solid figure for small incidence, but we would have been obliged to change the scale for oblique angles of incidence, and the result thus would have been quite misleading.

We utilised for that purpose the Samson Flamstead system of projection which enables one to retain the idea of the sphere. But, in order to get less distortion, at places where the variation was greatest, we cut the diagram in two parts corresponding each to a quarter of a sphere, the common point of the two parts of the diagram corresponding to the vertical line perpendicular to the middle of the sample.

In order to make the measurements more rapidly, we devised a system of photographic recording of curves.

The arm carrying the receiver was fitted with a toothed wheel (Fig. 4) by a screw attached to the rotor of a motor fitted with a threephase rotor and excited with singlephase a.c. A similar receiving motor was driving a wheel on which the photographic paper was attached. The whole equipment was so combined that the wheel carrying the photographic paper made a half turn while the arm carrying the cell also made a half turn. The recording paper was placed in a light-proof box (Fig. 5

and 6), and a horizontal slit was provided on the side along a horizontal radius. The luminous spot of the galvanometer then gave a vertical streak of light which intersected with the slit, and printed a point on the photographic paper.

In this way we have been so able to make a great number of determinations and to measure effectively the brightness factor of five samples of dry pavements, namely: asphalt (highly polished), bituminous coating, concrete pavement, stone pavement, wooden pavement. These street surfaces seem to cover all the range of coating and pavements usually employed, from the most to the least diffusing.

The general results are as follows:—

(1) The brightness factor (ratio between brightness and illumination at test point) increases very fast when the incidence of light increases.

(2) The same factor is always greater in the incident plane than in other vertical planes.

(3) Its maximum is always obtained for directions approximating to the horizontal.

The results obtained for the dry pavements previously mentioned are quite complete, having been made for incidence angles which run from 40° to 87° by steps of 10°. These steps of 10° have been restricted, for the most extreme variations (due to greater incidence or observation angles) to steps of 5°, 2°, and even 1° for samples showing very little diffusion. We are presenting herewith results for asphalt and bituminous coating for the incidences of 40° and 87° (Figs. 7a and b, and 8a and b).

We also give curves (Fig. 9) showing the variation of brightness factor in the plane of incidence for the five different coatings previously mentioned.

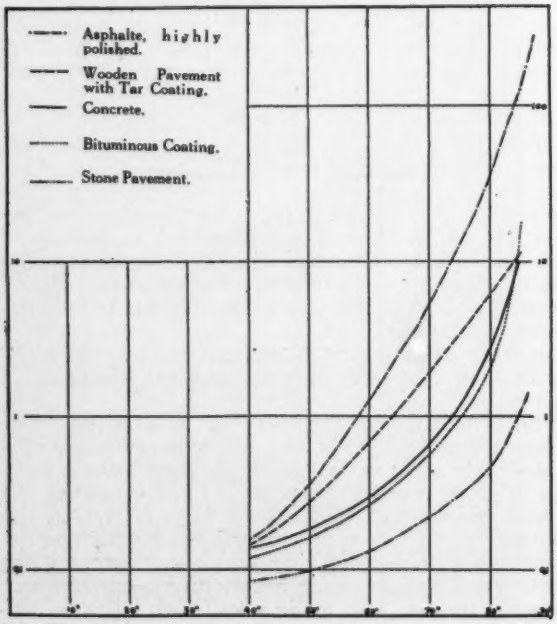


Fig. 9. Showing variation in brightness factor.

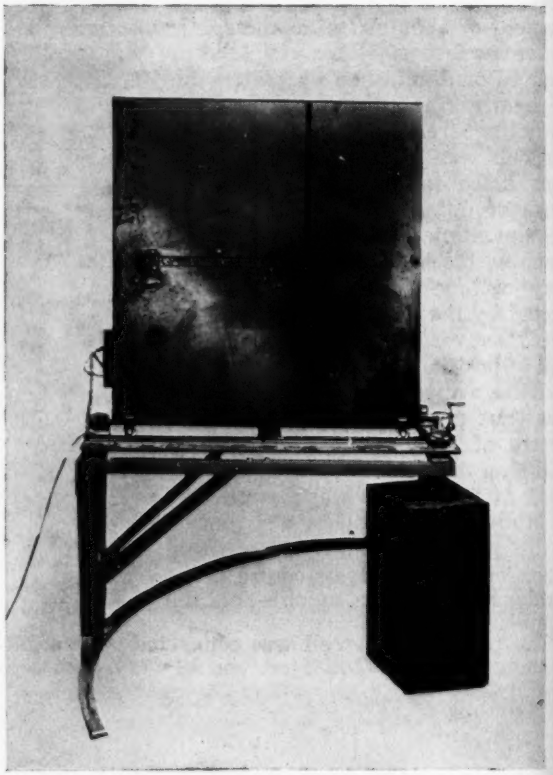


Fig. 6. Another view of the light-proof box.

From these results one can compute in advance the brightness on any given point on street surface, knowing the position of the sources, of the observer, and the light distribution of fittings. As an example, we have already computed for asymmetric reflectors and a given position of an observer the brightness distribution on a street surface The results found check very well with those which would have been found experimentally, namely, the position of a streak with a maximum brightness extending between lamp-post and observer.

Wet Surfaces.

First of all we must define what can be termed a wet road. If we study the variation of brightness factor immediately after wetting the surface, we find that this factor changes very much with evaporation and also very much with the angle and plane of observation. If we examine the variation in the incident plane, under a small angle of observation with the horizontal, we find that the brightness factor diminishes very much when the sample gets dry (Fig. 10). If, on the contrary, we examine the variation in a direction vertical to the surface, we find that the brightness factor increases very much when the sample gets dry (Fig. 11).

Compressed Asphalt.

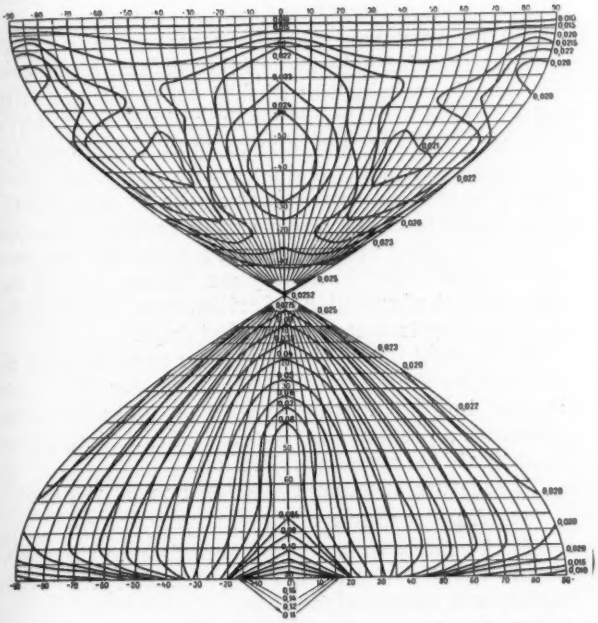


Fig. 7a. Incident Angle 40°

Compressed Asphalt.

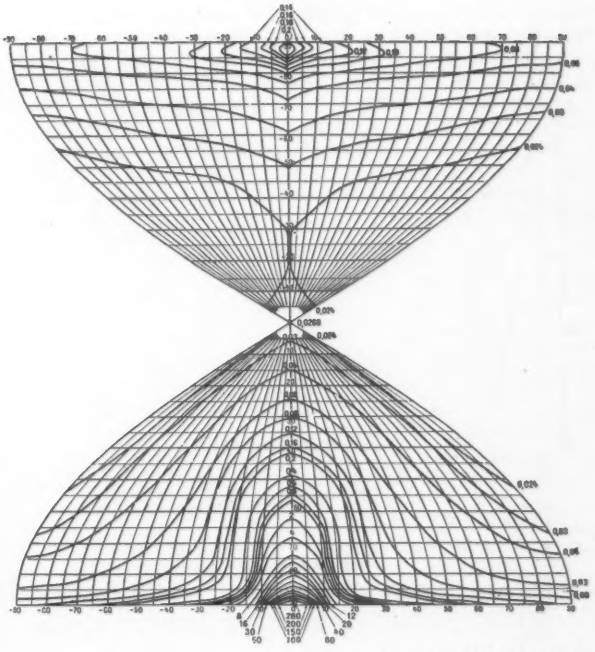


Fig. 7b Incident Angle 87°

Bituminous Coating.

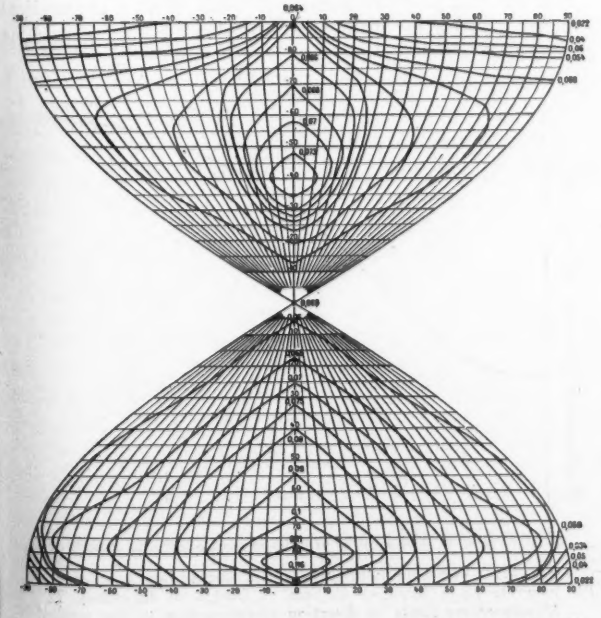


Fig. 8a. Incident Angle 40°.

Bituminous Coating.

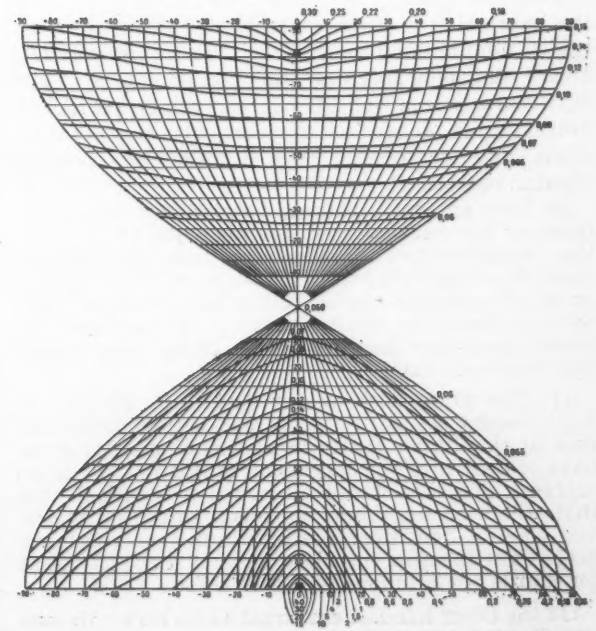


Fig. 8b. Incident Angle 87°

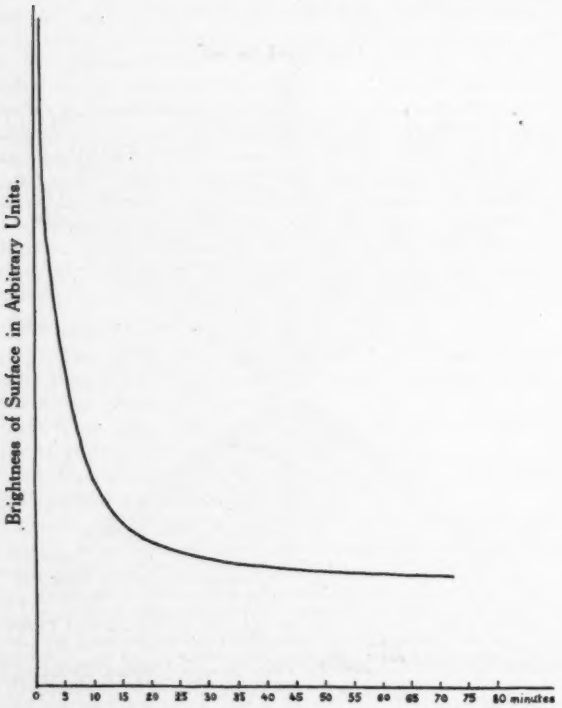


Fig. 10. Variation in brightness of a wet surface composed of concrete, as a function of time. (Angle of Incidence 72°. Measurements made in the direction of specular reflection.)

When we speak of wet roads, we immediately form the impression of bright patches and glare by reflection of light in puddles of water. We are immediately aware that some specular reflection must occur. But is it real specular reflection? Does it increase like reflection upon the surface of water, with the incidence angle, and, in general, does it follow the laws of regular reflection?

In fact, as Mr. Waldram pointed out in his extremely interesting paper dealing with "the reflection characteristics of road surface and their influence upon street lighting practice," one does not get a clear image of luminous sources, but a long streak of light, more or less wide, having, usually, its maximum between lamp-post and observer. These long streaks may have two causes:—

(1) The unevenness of the surface. We can, in fact, imagine, as Mr. Paterson pointed out in his lecture at the Junior Institution of Engineers, that we have to deal with the succession of mirrors of curved surfaces, and that the phenomenon is identical with that which occurs when the moon shines on water, and when a light breeze is blowing; each ripple reflects light towards the observer and the final result for him is a continuous streak of light.

On the other hand, these streaks also occur, though to a limited extent, with dry pavements, for which there is no specular reflection in the geometrical sense of the term, but which show a concentration of reflected light in directions neighbouring the direction of specular reflection.

(2) In other words, are the streaks due to regular reflection on irregularities of the surface, which could be called irregularities of first order (irregularities which could be detected by the naked eye)? Or, on the contrary, are they due to specular reflection on very small elements and on the film of water, which could be called irregularities of the second order?

In order to utilise these streaks, which are essential in building up contrast on a wet road, we must try to understand how they are formed, and if they are a result of specular reflection, or of mixed reflection, and try to ascertain to what degree.

We thought of utilising the same experimental disposition as the one previously used for dry pavements; but this setting, whilst adequate for reflection with a predominant account of diffusion, proved inadequate for specular reflection.

To measure specular reflection one must have:

(1) A point source of light.

(2) A sample so small in comparison to the source and to the distance from the source that the inverse square law applies rigorously.

(3) A receiver of such area that, in comparison with the distance to the sample, the inverse square law applies equally.

We found that a lamp filament only a few centimetres in dimensions was still too big to be considered as a point of source of light. With a theoretical point source of light, the incident beam would be

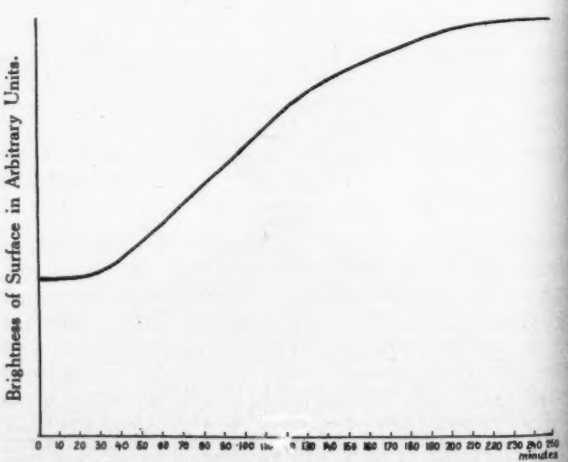


Fig. 11. Variation in brightness of a wet surface composed of concrete as a function of time. (Angle of Incidence 72°. Measurements made in direction corresponding to the vertical in the middle of sample.

exactly defined by a cone of light, and the perfectly reflected beam should be entirely located within the prolongation of a cone symetrical with the incident one in relation to the source. We therefore substituted for our 5 kW. lamp a small projection lamp, the filament of which could be really considered as a point source of light in relation to the distance. For the same reason, the area of the sample had to be smaller than the area previously utilised in order to obtain a narrower cone of regularly reflected light.

The decrease of luminous flux of the source and the diminution in the area of the sample led to a corresponding decrease in reflected flux. Wishing to avoid the use of current amplifiers, we decided to replace the cell utilised as receiver by a camera held by the exploring arm. The brightness of sample could then be measured by the blackening of the plate; if, at the same time, we could get, during the same exposure, a photograph of a scale of known brightness.

We are now working on this new experimental device and on a system of exploration of plates to measure the blackening, which means the brightness.

In this way we should be able to measure the proportion of specularly reflected light, if there is any, and to know what is the amount of this regularly reflected light in relation to the incidental flux.

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